MEASUREMENTS OF INJURY-RELATED OUTCOMES: STATISTICAL AND ANALYTICAL DATA FROM ALBANIA

SCORES DE GRAVITÉ APRÈS BRÛLURE: ANALYSE DES DONNÉES ALBANAISES

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SUMMARY. Numerous burn mortality indicators and prognostic scores are necessary to classify with priorities severely burned patients in order to predict outcome. The purpose of this paper is to evaluate mortality predictors on admission, in order to determine Lethal Area 50 and to validate burn prognostic scores. The study is retrospective, clinical and analytical. The data utilized were accessed by investigating the medical charts of 5033 patients hospitalized with severe burns within the Intensive Care Unit of the Service of Burns in Tirana, Albania over the period 1992-2019. Descriptive and inferential statistics were performed using PSS 23 software. Statistical significance is defined as $p<0.05$. The incidence rate of hospitalization of patients with severe burns initially increased from 4.1 to 7.9 persons per 100,000 population/year in the period 1992 to 1999, followed by a decrease from 7.9 to 4.8 in 2019. Mortality was 12.2% and the average burn crude death rate was 0.7 patients per 100,000 population/year. Lethal Area 50 for the second decade (2010-2019) was 82.2%. All tested burn prognostic scores had good predictive values. In addition to the commonly used outcome predictors such as age, burn size and inhalation burn, we concluded that additional determinants like depth of burn and etiology of burns determined an unfavorable outcome. Fatality risk was 4 times higher in patients with full-thickness burns, 2.6 times higher in patients with flame burns, and 4 times higher in patients with inhalation injury.

Keywords: burns, outcome, prognostic scores

RÉSUMÉ. *De nombreux scores de gravité se proposent d'évaluer le devenir des patients brûlés. Cette étude rétrospective, clinique et analytique, a pour but d'évaluer et valider ces différents scores ainsi que de déterminer la « surface létale 50- SL50 ». Elle a utilisé les dossiers de 5 033 patients hospitalisés dans le secteur de réanimation du CTB de Tirana entre 1992 et 2019. L'incidence annuelle a augmenté de 4,1 à 7,9/100 000/an entre 1992 et 1999 puis est redescendue pour atteindre 4,8 en 2019. Avec une mortalité hospitalière de 12,2%, la mortalité par brûlure à l'échelle de la population albanaise était de 0,7/100 000/an, la SL50, évaluée entre 2010 et 2019, étant à 82,2% SCT. Si tous les scores existant avaient un bon rendement prédictif, nous proposons d'adjoindre à l'âge, la surface brûlée et l'inhalation de fumées, la profondeur et l'étiologie de la brûlure comme facteurs de mauvais pronostic. Le décès était 4 fois plus fréquent chez des patients ayant une brûlure profonde (même risque en cas d'inhalation de fumée) et 2,6 fois plus fréquent après brûlure par flamme.*

Mots-clés : *brûlure, évolution, scores pronostiques*

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Introduction

Burns are a universal community prosperity issue, accounting for an estimated 180,000 deaths every year, predominantly in low-and middle-income nations.[1]

Progress within the field of burns has been accompanied by improving survival rates, reduced hospital length of stay (LOS), decreased morbidity and mortality rates due to advancements in protocol utilization, control of infection, dynamic and appropriate surgical treatment, early enteral and parenteral nutrition, and respiratory and hypermetabolic support.

Burn mortality indicators and prognostic scores are fundamental in arranging to triage burned patients according to the seriousness of the problem. The majority of burn prognostic scores like Baux score, revised Baux score, Abbreviated Burn Severity Index (ABSI) score, Ryan score and Belgium Outcome Burn Injury (BOBI) score are validated in numerous studies.[2,3,4,5] Age, body surface area (BSA%) burned and especially presence of inhalation burn have more than once been identified as important donors to a disadvantageous end result.[6,7,8]

Burn wounds constitute an important burden for Albania's healthcare system.[9] Changed from one of the poorest nations in Europe in the early 1990s following communism to an upper middle-income nation in 2008, Albania remains a region with a large count of severe burn patients compared to the average European country.[10,11] As such, the data analyzed in this study encompass not only an extensive period of time but also an important evolution in the healthcare system. Data for this study were gathered only from The University Hospital Center "Mother Teresa" (UHC) in Tirana, the only tertiary healthcare center in Albania. As the only burn center, the burns service established in September 1973 admits burn patients from the entire geographic range of the country. Development of new healthcare strategies prompted this retrospective analysis of mortality among the severe burns population in Albania.

Outcomes of past and present trends of demographic and epidemiologic features of severe burns represent an evolution in the economy and healthcare, and form a starting point for future reforms.

The purpose of this paper is to evaluate mortality predictors on admission, to determine Lethal Area 50 (LA 50) for the period 1992-2019 (28 years), and to validate the use of burn prognostic scores (Baux score, ABSI score, Ryan score, BOBI score, revised Beaux score) in our population.

Material and methods

Study setting

The study was performed in the burns service, which contains 35 hospital beds for patients with severe burns, patients with trauma, and patients who need reconstructive and esthetic surgery. It consists of the Emergency Unit, the Operating Theatre, the Intensive Care Unit (ICU) with 10 beds, and the Ward.

The requirements for hospitalization within the ICU are based on American Burn Association criteria.[12] Admission is also possible for burns of less than 10% BSA if the patient is a child or elderly and needs resuscitation, or if the burns are localized in important areas.[13]

Treatment of burn patients is performed according to hospital guidelines for major burn resuscitation, for local and surgical treatment as well as for the rational use of antibiotics and human albumin starting from 2015. Fluid resuscitation for burns is performed using the Parkland formula for adults (sometimes we add colloids) and Shriner's Galveston formula for children. Meticulous monitoring during the fluid resuscitation period is guided by diuresis, with the aim of avoiding over-resuscitation. During the second 24 hours, colloids, especially human albumin, account for two thirds of the total volume.

After cleaning with chlorhexidine as well as betadine solution, partial thickness burn wounds are dressed with hydrocolloids or antibiotic ointments, and the full thickness parts only with silver sulphadiazine cream. Early excisions are performed at whatever point judged vital by the staff, but don't frame a schedule strategy. In treating full thickness burns, we perform different cuts during the primary week, essentially with the necrotomy method. These cuts decrease edema, maintain a strategic distance from compartment syndrome, and offer assistance in the disposal of necrotic tissue at the conclusion of the moment or third week. Mi-

crobiological checking, performed twice a week, is used to indicate the patient's bacterial colonization status.

Study design

The study is designed as a retrospective clinical and analytical cohort. The data utilized were accessed by the investigation of the medical charts of 5033 patients hospitalized with severe burns within the ICU of the Burns Service in Tirana, Albania over the period 1992-2019. These patients constitute all the cases of moderate and severe burns nationwide, as our center is the only specialized center in the country. This study was approved by the Ethics Committee at the Ministry of Health and Social Protection of Tirana.

Considering the broad time frame of the study, the population analyzed was divided into three time periods: 1992-2000, 2001-2009 and 2010-2019. We have excluded from the study patients with Steven-Johnson, toxic epidermal necrolysis and trauma patients.

Information collected included:

- Age
- Population classified according to 10-year age groups, as well as Children 0-14 years, Adults 15-59 years and Elderly ≥60 years
- Gender (male, female)
- Etiology of burns (scalds, flame, electrical, chemical, others)
- Body surface area (BSA%) burned: (0-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-60%, 61-70%, 71-80%, 81-90%, 91-100%)
- Degree (partial-thickness, full-thickness)
- Presence of inhalation injury (yes/no). Inhalation injury included patients when there was exposure to fire, steam or items of combustion along with laboratory results and with positive bronchoscopy discoveries underneath the vocal cords
- Length of hospital stay (LOS) (days)
- Outcome (deaths, survivors)

Prognostic scores used for analyzing mortality are as follows:

- Baux and Revised Baux score
- Age (years) + Total Body Surface Area Burn (percentage, %) +17 (if presence of inhalation injury in the case of Revised Baux score)[2]
- The score is a comparative indicator of burn severity, with a score over 140 indicating unsurvivable, depending on the available treatment resources.
- Abbreviated Burn Score Index (ABSI). The ABSI, published in 1982, ranges from 2 to 18 points, resulting in six risk categories, with a probability of survival ranging from ≥99% (threat to life very low) to ≤10% (threat to life maximum). The ABSI reflects on the following risk factors: female gender (1 point), increasing age by 20 years (1–5 points), increasing BSA(%) burned by 10% (1–10 points), presence of inhalation injury (1 point) and presence of full thickness burns (1 point).[3]
- Ryan model. It is a framework that predicts mortality, taking into consideration three major hazard components: age 60 years or over (1 point), burned surface zone (BSA) more than 40% (1 point), and the existence of an inhalation burn (1 point). This equation predicts 0.3%, 3%, 33%, and approx. 90% mortality when, individually, zero, one, two, or three focuses are displayed.[4]
- Belgian Outcome in Burn Injury (BOBI) score. The BOBI score uses absolute values of age divided into four groups (0-3 points), of BSA(%) divided into 5 groups (0-4 points) and the presence of inhalational burn (no=0 points; yes=3 points). This formula predicts mortality by total score. Based on total score (0-10 points), predicted mortality ranges between 0.1% and 99%.[5]
- LA 50 is characterized as the burn measure deadly to 50% of patients

Statistical analysis

SPSS 23 software was used to conduct the statistical analysis. Incidence density rates and burn crude death rates are calculated as number of burn admissions (burn deaths) in any age group in one year multiplied by 100,000 and divided by the total persons at risk (the population for a particular year is taken from our Institute of Statistics).

Descriptive and inferential statistics were used to give data and to conclude. Simple linear regression

was used for estimating lethal area 50 (LA 50) and binary logistic regression for estimating predictors of LOS. ANOVA was used for comparing data from the three time periods and to test for equality of the three population proportions. Survival analysis through Kaplan Meier and receiver operator characteristic (ROC) curve were used to test the diverse score records against each other. Statistical significance was defined as $p<0.05$.

Results

Incidence and death rate from burns

During 1992-2019, 11,364 patients in total were hospitalized in the Burns Service, with an average hospitalization of 783.7±129.5 patients per year, while 5033 patients were hospitalized in the ICU with an average 179.5±31.2 patients per year. Mean LOS of ICU patients was 11.3±2.1 days. The incidence rate of hospitalization of patients with severe burns in the ICU initially increased in the period 1992 to 1999 from 4.1 to 7.9 burn patients per 100,000 population per year, followed by a decrease from 7.9 to 4.8 burn patients per 100,000 population per year in 2019 (*Fig. 1*).

During the whole inclusion period, the incidence rates of severe burns in children decreased from 4.1 to 2.3 patients per 100,000 population per year, with a yearly drop of 4.8%, (3.5, 95%CI [5.7, 2.1]). In adults, the incidence rates of severe burns increased from 0.9 to 1.8 burn patients per 100,000 population per year, with a yearly increment of 11%, (0.90, 95%CI [1.85, 1.95]). For the elderly the incidence rate of severe burns increased from 0.3 to 0.5 burn patients per 100,000 population per year, with a yearly increment of 7.4% (0.69, 95%CI [0.3, 0.5]).

There were 617 deaths with overall mortality 12.2% and an average burn crude death rate of 0.7 deceased burn patients per 100,000 population per year. Fire burn deaths mounted up to 336 patients with an average fire burn crude death rate 0.4 patients per 100,000 population per year. Burn crude death decreased from 1.04 to 0.28 patients per 100,000 population per year with an annual decrease of 2.6% (0.72, 95%CI [0.20, 1.52] (*Fig. 1*).

The number of deaths from all causes in Albania during the period 1992-2019 was 554,390, of which 36,659

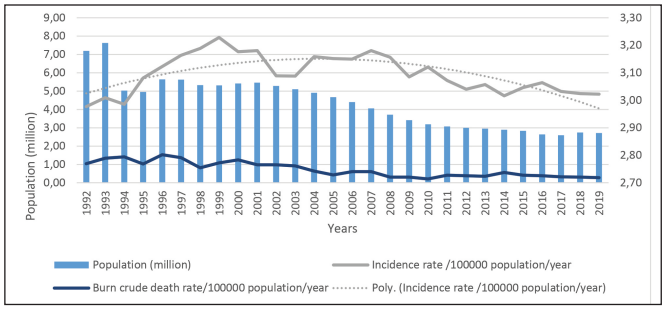


Fig. 1 - Incidence rate of severe burn patients hospitalized in the ICU and burn crude death rate per 100000 population/year during 1992-2019 (n=5033, deaths=617)

or 6.61% were deaths from trauma, poisoning and accidents. In a total population of 2,989,809 inhabitants (on average), this represents a crude all injury death rate of 39.6 per 100,000 population per year (minimum 27.6 in 2018 and maximum 82.7 in 1997). These data are taken from INSTAT (Institute of Statistics in Albania). INSTAT uses the international classification of diseases (ICD-9) with the main sources of information being data from the Ministry of Health and Social Protection.[9,11]

Patient demographics and burn injury characteristics

In *Table I*, the statistical calculations and the clinical profile of the burn patients included in the study in the three time periods are presented. In the period 1992-2000, there were 1678 patients, 59.4% were male and 40.6% were female, 63.2% were <10 years

Table I - Demographic, clinical and burn injury characteristics 1992-2019 (n=5033)

	1992-2000	2001-2009	2010-2019	
	(n=1678)	(n=1840)	(n=1515)	p
Age, mean (SD)	16.1(2.9)	19.4(2.7)	25.7(3.1)	<0.0001
Gender, % female (n)	40.6(682)	37.8(696)	38(577)	0.469
Group ages (years), %(n)				
<10	63.2(1062)	55.9(1030)	47.7(723)	<0.0001
10-19	7.2(121)	8.4(156)	5(76)	0.001
20-29	7.2(121)	4.7(88)	7.5(114)	0.003
30-39	6(102)	7.5(139)	6.1(93)	0.178
40-49	6(102)	9.4(173)	10.6(162)	<0.0001
50-59	3.6(61)	6.6(122)	8.8(134)	<0.0001
60-69	3.1(53)	3.2(59)	7.3(112)	<0.0001
70-79	2.3(39)	2.7(51)	3.9(60)	0.026
>80	1(17)	1.2(22)	2.7(41)	<0.0001
Etiology of burns, %(n)				
Scalds	73.9(1240)	60.1(1107)	49.3(748)	<0.0001
Flame	18.6(313)	26.4(487)	40(607)	<0.0001
Electrical	2.6(45)	4.1(76)	5.3(81)	0.001
Chemical	3.6(61)	7.8(145)	4.8(73)	<0.0001
Others	1.1(19)	1.3(25)	0.4(6)	0.017
BSA% burned, mean (SD)	24.5(2.8)	22.7(2)	25.6(2.8)	<0.0001
Full-thickness burn, %(n)	23.2(390)	21.7(401)	16(243)	<0.0001
Inhalation injury, %yes (n)	13.9(234)	12(221)	15.7(239)	0.023
Mechanical ventilation, %yes (n)	5.7(96)	4.3(80)	4.4(68)	0.15
LOS, mean(SD)	11.1(2.1)	10.9(2.1)	12(2.1)	<0.0001
Mortality, %(n)	19.9(335)	9.5(175)	7(107)	<0.0001
Mortality in patients with inhalation injury, %(n)	64.9(152)	39.3(87)	37.2(89)	0.002
Mortality in patients without inhalation injury, %(n)	12.6(183)	5.4(88)	1.4(18)	<0.0001
Mortality Children (0-14y), %(n)	17.1(195)	6.8(76)	0.9(7)	<0.0001
Mortality Adults (15-60y), %(n)	19.8(86)	10.5(63)	7.7(42)	0.002
Mortality Elderly (≥60 y),%(n)	49.5(54)	27.2(36)	27.2(58)	0.006

of age and 73.9% had scalds as the causative agent. The mean age of the patients was 16.1±2.9 years, mean BSA(%) was 24.5±2.8, full-thickness burn was present in 13.9%, and 96 of them, or 5.7% of the total, required mechanical ventilation. Mean LOS was 11.1±2.1 days. Mortality was high in general, i.e. 19.9% (335 deaths among 1678 patients) and in the three main age groups, namely 17.1%, 19.8% and 49.5% for children, adults and the elderly, respectively. Mortality in patients with inhalation injury was 64.9% vs. 12.6% in patients without.

In the period 2001-2009, there were 1840 patients. There was a recurring male predomination (62.2%) and 55.9% were <10 years of age, however there is a noticeable increment in the number of patients in the adult and elderly age groups. Although scald burns were present in 60.1% of the total number, in comparison with the previous decade there was an increment in the number of patients burned by flame, electrical and chemical agents, i.e. 26.4%, 4.1% and 7.8% respectively. The average age of the patients was higher, namely 19.4±2.7 years, while values for other data (mean BSA%, presence of full-thickness burn, inhalation injury and LOS) were comparable to the data of the previous decade. There was an improvement in overall mortality (9.5% of all included patients: 175 patients out of 1840), which is reflected in the three main age groups, especially in children (mortality was 6.8%). Mortality in patients with inhalation injury was 39.3% vs. 5.4% in patients without.

In the final analyzed period (2010-2019), there were 1515 patients. Approximately half were children up to 14 years old, where 47.7% were <10 years of age. The mean age of the patients was 25.7±3.1 years, 40% of the total number had flame as the causative agent, and mean BSA% was higher than in the previous decades at 25.6%. Presence of inhalation injury and LOS were higher, while mortality decreased up to 7%. In the children group mortality was lower at 0.9% (7 deaths out of 763 patients 0-14 years), in the adults group mortality was 7.7% (42 deaths out of 539 patients), while there was no improvement in mortality regarding the elderly population. This latter remained at 27.2%. In patients with inhalation burn, mortality remained the same as in the previous decade but there was a change in the patients without inhalation damage.

Analysis of mortality with burn injury characteristics

Overall mortality for all patients was 12.2%. Mortality in patients with inhalation burn was 47.2% (328 deaths out of 694 patients) while in patients without inhalation burn mortality was 6.6% (289 deaths out of 4339 patients). Data for mean age and mean BSA(%) burned of patients in all periods of the study are presented in *Fig. 2*. In this figure, there is a clear correlation of expanding age and burn measure with an increment in mortality. However from linear regression, 21.1% of variance of BSA(%) and only 2.9% of variance of age are responsible for bad outcome.

In *Fig. 3* we present the main etiologic factors and the corresponding mortality rates. There was elevated mortality in patients with flame burns, with the presence of full-thickness burn and with the co-existence of inhalation burn. In *Fig. 4* we present the LOS for deceased and survivors as well as the LOS for different burn sizes. There was a higher LOS in survivors, who had burn sizes from 40% to 79% BSA.

In *Fig. 5* we present the Kaplan-Meier plots showing the survival trajectories (total likelihood of a person remaining alive during LOS) for two variables: the presence of inhalation burns and full thickness burns. The Kaplan-Meier plots show that the survival likelihood is lower in patients with inhalation injury and in patients with full-thickness burns at all time focuses (LOS) so they are less likely to survive. The log-rank test investigates the theory that there is no distinction in survival times between the bunches examined. Based on a p-value of <0.001 in both cases, we concluded that the two curves are statistically different.

A binary logistic regression was performed for the following predictors: age, BSA(%), presence of full-thickness burn, presence of inhalation burn and cause of burns for all the periods studied (R^2=0.386 which means that 38.6% of variance can be explained by the predictors in the model, p<0.0001). In order to interpret safely the odds ratios (Exp B), we firstly took into consideration the predictors with p value <0.05. Then we analyzed the continuous variable BSA(%) burned, so for each unit of increase in BSA(%) there is increasing odds of a bad outcome by 0.9 while age alone has no statistical significance (p=0.11). For categorical variables such as in the case

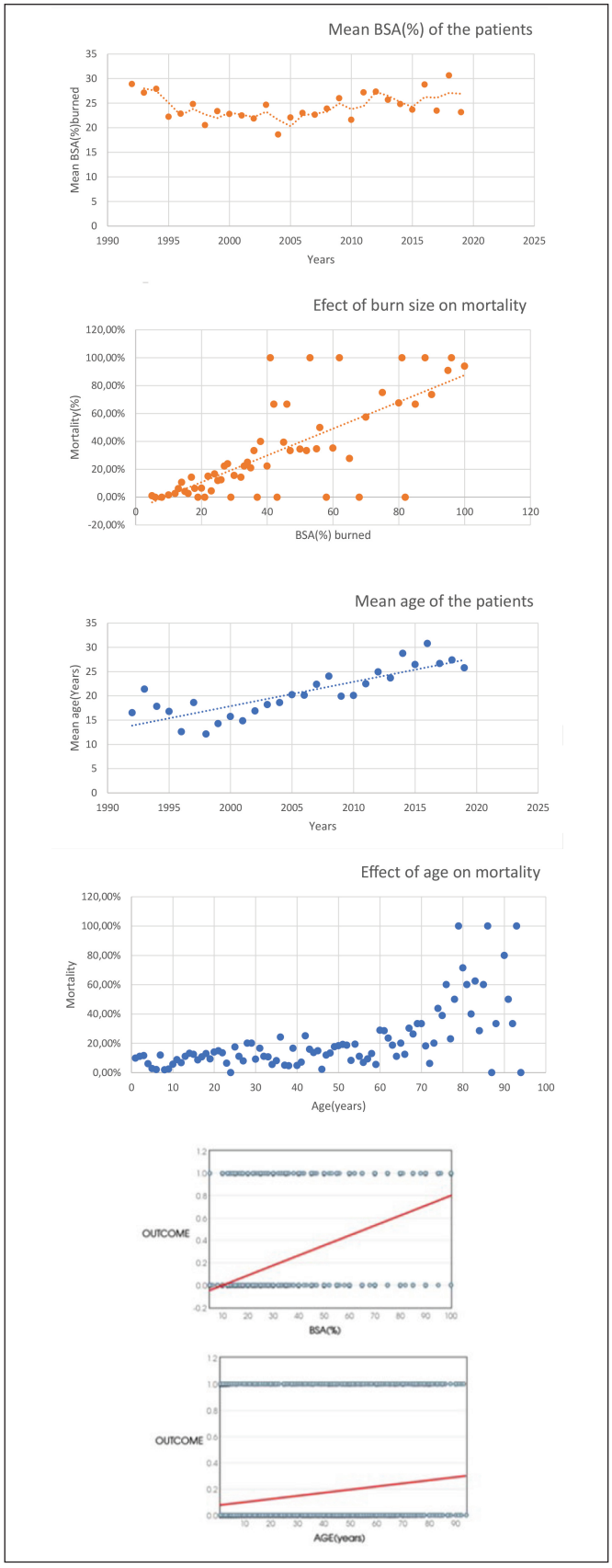


Fig. 2 - Data regarding age and burn size of the patients in the study (n=5033). From linear regression, 21.1% of variance of burn size (%) and only 2.9% of variance of age are responsible for bad outcome

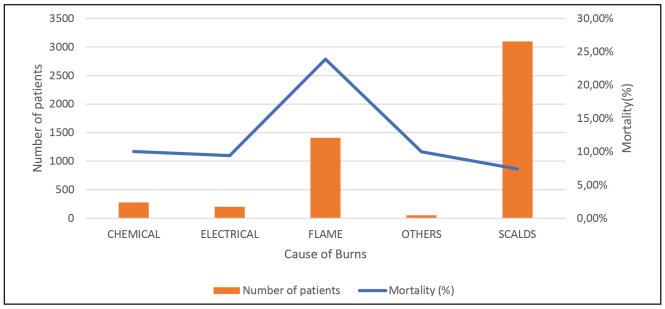


Fig. 3 - Mortality according to etiology of burn

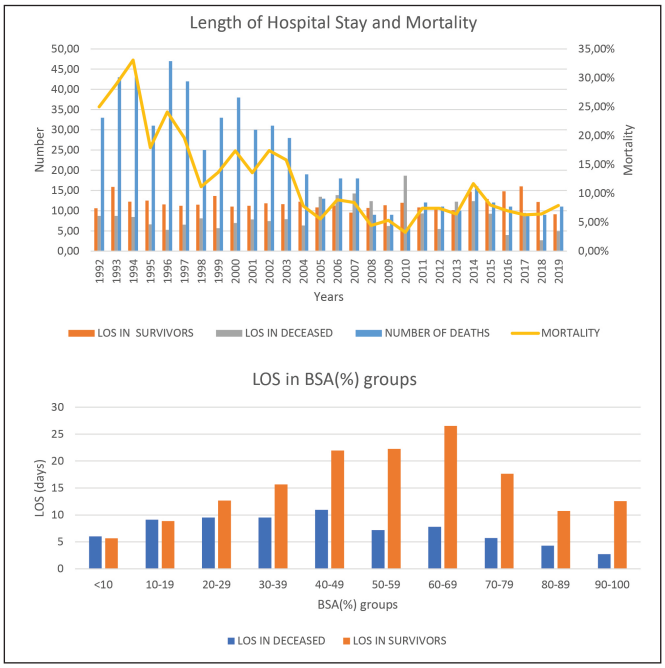


Fig. 4 - Length of hospital stay in deaths and in survivors over the years and in different burn sizes

of presence of inhalation burn and full thickness burn there was a positive relationship, resulting at 4 times greater odds of a bad outcome. Having flame burns results in 2.6 times greater odds of a bad outcome, while other causative agent groups (scalds and electrical burns) result in approximately 2 times greater odds of a bad outcome (*Table II*).

Calculation of LA 50

LA50 is a well-established index suitable for assessing quality of care in burn patients by taking into consideration only age and BSA(%) burned. We calculated this index for all patients as well as for each of the three periods with linear regression. LA50 for all patients was 66.4%, while for the first decade 1992-2000 it was 49.8%, for 2000-2009 it was 73.3% and for the period 2010-2019 it was 82.2% (*Fig. 6*).

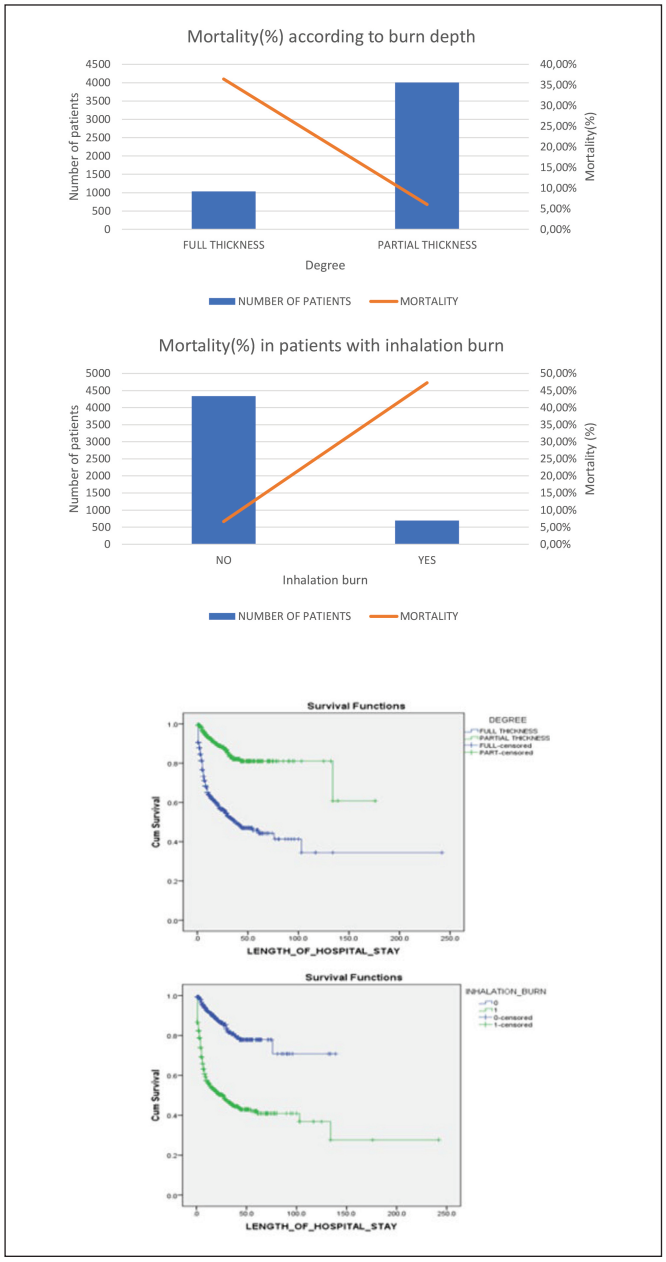


Fig. 5 - Mortality and survival analysis in patients with full-thickness burns and with presence of inhalation injury (n=5033)

Table II - Multivariable logistic regression analysis assessing relationship with mortality in 5033 burned patients (1992-2019)

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
AGE (years)	-0.004	0.002	2.549	1	0.11	0.996	0.991	1.001
BSA(%) burned	-0.044	0.003	247.688	1	0	0.957	0.951	0.962
Presence of full thickness (yes)	1.421	0.117	148.493	1	0	4.143	3.296	5.208
Inhalation burn (yes)	1.438	0.16	80.907	1	0	4.214	3.08	5.765
Cause of burn			23.864	4	0			
Scalds	0.658	0.254	6.72	1	0.01	1.932	1.174	3.178
Flame	0.966	0.298	10.524	1	0.001	2.627	1.466	4.71
Electrical	0.739	0.171	18.652	1	0	2.095	1.498	2.93
Chemical	0.795	0.582	1.862	1	0.172	2.214	0.707	6.933
Constant	1.042	0.208	25.152	1	0	2.834		

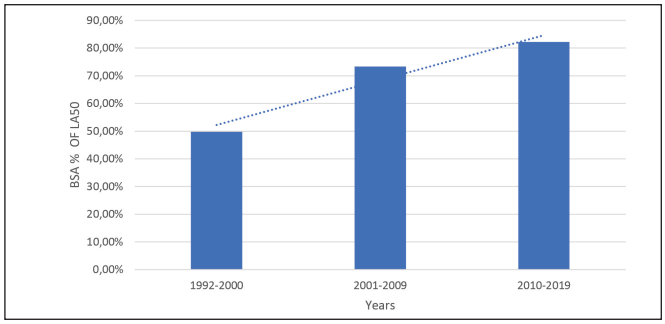


Fig. 6 - Lethal Area 50 of patients in three periods of the study

Validation of predictive mortality scores in all patients

The present study showed that, in all burned patients, the Baux score ranged from 6 to 193 with a mean of 44.1±32; Revised Baux score ranged from 6 to 210 with a mean of 46.4±35.3; ABSI score extended from 2 to 17 with a mean of 5.1±2.6; Ryan score ranged from 0 to 3 with a mean of 0.4±0.7 and BOBI score ranged from 0 to 10 with a mean of 1.4±1.9.

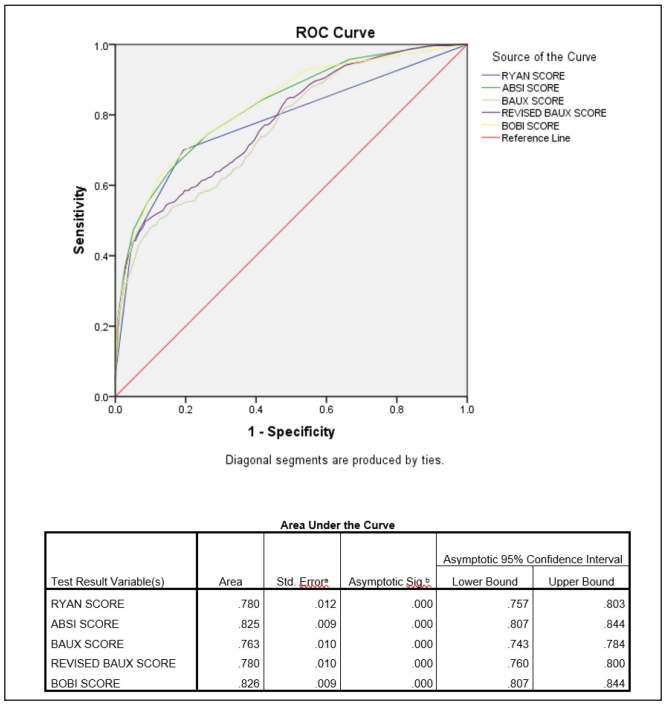
In the deceased patients (n=617), the Baux score ranged from 11 to 193 with a mean of 75.5±42.3; Revised Baux score ranged from 11 to 210 with a mean of 84.6±47.8; ABSI score ranged from 2 to 17 with a mean of 8.4±3.5; Ryan score extended from 0 to 3 with a mean of 1.2±1.0 and BOBI score ranged from 0 to 10 with a mean of 3.8±2.6.

In *Table III* we present data from the Baux, Re-

Table 3 - Death prediction during 1992 to 2019 (n=5033)

	POINTS	SURVIVE	DEATHS	TOTAL	MORTALITY		DEATHS		
					Observed(%)	Predicted(%)	Predicted(%)		
SCORES		Observed	Observed	Observed			from	to	Average
ABSI score	**2-3**	1475.0	26.0	1501.0	**1.7**	**1.0**	15.0	15.0	15.0
	4-5	1787.0	132.0	1919.0	**6.9**	**2.0**	38.4	38.4	38.4
	6-7	748.0	118.0	866.0	**13.6**	**10-20**	86.6	173.2	129.9
	8-9	287.0	115.0	402.0	**28.6**	**30-50**	120.6	201.0	160.8
	10-11	89.0	91.0	180.0	**50.6**	**60-80**	108.0	144.0	126.0
	>12	30.0	135.0	165.0	**81.8**	**90.0**	148.5	148.5	148.5
TOTAL		4416.0	617.0	5033.0	**12.3**		517.1	720.1	618.6
BOBI score	**0.0**	2007.0	44.0	2051.0	**2.1**	**0-1**	0.0	20.5	10.3
	1.0	1478.0	135.0	1613.0	**8.4**	**1-5**	16.1	80.7	48.4
	2.0	387.0	54.0	441.0	**12.2**	**5.0**	22.1	22.1	22.1
	3.0	180.0	57.0	237.0	**24.1**	**10.0**	23.7	23.7	23.7
	4.0	159.0	63.0	222.0	**28.4**	**20.0**	44.4	44.4	44.4
	5.0	109.0	69.0	178.0	**38.8**	**30.0**	53.4	53.4	53.4
	6.0	73.0	72.0	145.0	**49.7**	**50.0**	72.5	72.5	72.5
	7.0	18.0	74.0	92.0	**80.4**	**75.0**	69.0	69.0	69.0
	8.0	5.0	34.0	39.0	**87.2**	**85.0**	33.2	33.2	33.2
	9.0	0.0	12.0	12.0	**100.0**	**95.0**	11.4	11.4	11.4
	10.0	0.0	3.0	3.0	**100.0**	**99.0**	3.0	3.0	3.0
TOTAL		4416.0	617.0	5033.0	**12.3**		348.7	433.7	391.2
RYAN score	**0.0**	3562.0	185.0	3747.0	**4.9**	**0.3**			11.2
	1.0	649.0	165.0	814.0	**20.3**	**3.0**			24.4
	2.0	196.0	222.0	418.0	**53.1**	**33.0**			137.9
	3.0	9.0	45.0	54.0	**83.3**	**90.0**			48.6
TOTAL		4416.0	617.0	5033.0	**12.3**				222.2
BAUX score	**0-20**	1428.0	34.0	1462.0	**2.3**	**0-20**	0.0	292.4	146.2
	21-40	1327.0	161.0	1488.0	**10.8**	**21-40**	312.5	595.2	453.8
	41-60	610.0	66.0	676.0	**9.8**	**41-60**	270.4	405.6	338.0
	61-80	590.0	58.0	648.0	**9.0**	**61-80**	388.8	518.4	453.6
	81-100	324.0	101.0	425.0	**23.8**	**80-100**	340.0	425.0	382.5
	>100	137.0	197.0	334.0	**59.0**	**>100**	334.0	334.0	334.0
TOTAL		4416.0	617.0	5033.0	**12.3**		1645.7	2570.6	2108.1
Revised BAUX score	**0-20**	1415.0	32.0	1447.0	**2.2**	**0-20**	0.0	289.4	144.7
	21-40	1298.0	142.0	1440.0	**9.9**	**21-40**	302.4	576.0	439.2
	41-60	601.0	64.0	665.0	**9.6**	**41-60**	266.0	399.0	332.5
	61-80	540.0	56.0	596.0	**9.4**	**61-80**	357.6	476.8	417.2
	80-100	356.0	63.0	419.0	**15.0**	**80-100**	335.2	419.0	377.1
	>100	206.0	260.0	466.0	**55.8**	**>100**	466.0	334.0	400.0
TOTAL		4416.0	617.0	5033.0	**12.3**		1727.2	2494.2	2110.7

vised Baux, ABSI, Ryan and BOBI scores. Firstly, we divided patients according to their respective points of the prediction scores and we compared expected mortality to the observed data. We concluded that the mortality of the total population in these three decades was higher than the prediction in lower points of the ABSI, BOBI and Ryan score, while for Baux and revised Baux score the observed mortality was lower than the prediction. Only the ABSI score predicted a very similar value with the observed deaths (618 vs. 617 deaths). Area Under the ROC curve and the respective values were utilized to decide the prescient capacity of each score for bad outcome (*Fig. 7*). All scores resulted to be good predictors, with the BOBI and ABSI score being the most congruent with values of 0.826 and 0.825 respectively.



Area Under the Curve

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
RYAN SCORE	.780	.012	.000	.757	.803
ABSI SCORE	.825	.009	.000	.807	.844
BAUX SCORE	.763	.010	.000	.743	.784
REVISED BAUX SCORE	.780	.010	.000	.760	.800
BOBI SCORE	.826	.009	.000	.807	.844

Fig. 7 - ROC curve analysis for predictive scores (ABSI score, BAUX score, Revised BAUX score, Ryan score and BOBI score)

Discussion

This study analyzes the distribution in different groups of age, risk factors, causes and the tendency of severe burns, as well as mortality after burn injuries in Albania over a 28-year period, taking into consideration only burn characteristics on admission. As we mentioned above, we divided the study population into three time periods that we intend to talk about first.

The effects of the political and economic situation on the healthcare system in general and, in particular, the impact on the treatment of burn patients

1992-2000 marks the very beginning of democracy in Albania, with 1992 the first year where pluralistic election took place. The Albanian healthcare system was confronted with a drastic political change. Transition from the isolation of the socialist/communist regime together with economic challenges and civil disturbances in the first years of democracy threatened the healthcare system. This period was characterized by a lack of medical staff qualification, shortages of equipment, and a stringent need of international outreach for updates on medical procedures and protocols.

On average the age of the burned patients in this period was 16.1±2.9 years, with scalds being the most prevalent causative agent in 73.9% of the cases, frequently occurring in the home. Flame burns were present in 18.6% of patients, mainly in adults. The incidence rates for patients with severe burns hospitalized in the ICU from 1992 to 1999 increased from 4.1 to 7.9 patients/100,000 population/year. Mortality had higher values up to 19.9% in all three age groups. This is arguably directly related to the changes in the economic and political situation.

At the beginning of the new millennium (the study period 2001-2009), Albania's political and economic problems were fading. Adequate importance was attributed by the government to healthcare. As a result of governmental investments, major infrastructural changes happened in the University Hospital Center, including the Burns Service and Plastic Surgery. The medical staff were provided with opportunities of international fellowships. These offered the medical staff the possibility to update patient treatment, and to use new technology and treatment methods, greatly promoting progress. In our burn service the newest guidelines of resuscitation of severely burned patients and surgical treatment were introduced and applied.

The age of the patients, on average, in this period was higher (19.4±2.7 years). There was an increment in the number of patients burned by flame,

electrical and chemical agents. There was improvement in overall mortality, at 9.5%, and especially in mortality of patients with inhalation burn.

In the second decade of the new millennium (the study period 2010-2019), many clinical guidelines were drafted which drastically helped the treatment of severely burned patients. We note here a considerable drop in mortality rate compared with the previous decades. Some notable milestones were: the rational use of antibiotics and human albumin, metabolic support and the drastic improvement in local treatment of burns while using specific topic agents, as well as the creation of a modern instrument sterilization center in the university hospital center.

In 2010-2019 there was a decrease in the incidence rate of severe burns in children, up to 2.3 patients per 100,000 population per year. This was accompanied by an increase in the incidence rate in adults, 1.8 patients per 100,000 population per year, and an increase in the incidence rate in the elderly, up to 0.5 patients per 100,000 population per year. Although the mean age of the patients was higher (25.7±3.1 years), and 40% of burns were caused by flame, mortality rate was improved. There was an improvement in overall mortality in all patients (7%), and particularly in children (0.9%). LA50 was improved, at 82.2%.

Mortality predictors on admission

Burns in the elderly, with a large burn size and with the presence of inhalation burn, are well-known predictors of burn mortality, but on the other hand, infection and sepsis as well as concomitant illness and immunity status of the patients have a greater impact on overall mortality. In this study we focused only on burn characteristics at admission. According to some authors, the significant limit for post-burn morbidity and mortality at the cutting edge in the burn care setting is roughly 60% BSA burned in pediatric patients and 40% BSA burned for adult patients.[14,15] These conclusions highlighted the fact that patients with burns at or over these cutoff values are at high risk of considerable complications and death, even in profoundly specialized centers. From our data, a higher BSA(%) is associated with increased mortality but from our analysis (BSA as part of a model in prediction) through binary logistic regression, for each unit increase of BSA(%) there is increasing odds of a bad outcome by 0.9, while age alone has no statistical significance.

In accordance with the National Burn Repository of the American Burn Association, up to 10.3% of the burn patients have concomitant inhalation burn with the respective increase in mortality rate.[16] Our Kaplan-Meier plots show that survival probability is lower in patients with inhalation injury and in patients with full-thickness burns at all time points (LOS). Inhalation damage accompanying burns increases the risk of body harm and requires expanded volumes of liquid and sodium to achieve successful resuscitation from early burn shock.[17,18,19]

From our data, we support the view that inhalation injury contributes to mortality, which many authors found to be independent and additive.[20] According to them, the anticipated mortality is expanded by an extreme of 20% in the presence of inhalation damage alone, and 60% when both inhalation damage and pneumonia are displayed.[20] Results of the binary logistic regression indicate that the presence of inhalation burn is accompanied by a positive correlation to bad outcome: the same for patients with flame burns and burns from other causative agent groups (scalds and electrical burns).

Validation of burn prognostic scores in our population

Clinical expectation models evaluate the probability of illness (diagnosis) or an occasion within the future course of illness (forecast) for particular patients. Burn prognostic scores are developed to determine bad outcome. We analyzed the predictor scores with Area Under the ROC and all the scores had good predictive values. We applied all these scores in children, adults and the elderly. The revised Baux score, a replacement of the original Baux score, might be a straightforward and exact means for foreseeing mortality in patients with intense burn wounds in a burn center setting.[21] From our analysis, AUC demonstrated that Baux score and Revised Baux score was 0.763 and 0.780 with statistical significance, while there is overestimation in the calculation of the predicted deaths. The Abbreviated Burn Scoring Index (ABSI) is one of the most commonly used scores for assessing patient mortality, although some authors made modifications on this score.[22] For our unit this score is a very good predictor of

mortality, as together with the BOBI score, it had the highest AUC and it predicted the real number of deaths (n=618). Our results regarding ABSI are comparable with some authors,[23] although others share the opinion that mortality is overestimated with this score.[24]

The Ryan score is a reliable score but the BOBI score had the highest discrimination value for us. In the current study, the area under the curve (AUC) demonstrated by the BOBI score was 0.826 (95% confidence interval: 0.807-0.844), which was the same as that reported by some authors and slightly lower than that reported by others (95% CI: 0.89-0.98 and AUC: 0.94).[25,26] The previously-mentioned data are for the whole period of the study, but there was a reliable prediction of mortality by prognostic scores especially in the last period (2010-2019). We think this is due to the overall improvements regarding the qualified treatment of burn patients in our unit. In *Table IV* we present values, relating to the three periods, for ABSI, BOBI and RYAN scores, and it is evident that in the third decade there is a correlation of predicted mortality with that observed, especially for BOBI and Ryan scores.

Conclusions

Among 5033 patients, there were 617 deaths with overall mortality 12.2%. The mean LOS was 11.3±2.1 days. There was a higher LOS in survivors, who had burn sizes from 40% to 79% BSA. From 1992 to 2019, mortality decreased in the last decade up to 7% and particularly in children mortality was 0.9%, which suggests major efforts have been made in burn care in Albania. Burn crude death decreased from 1.04 to 0.28 cases per 100,000 population per year. Mortality in patients with inhalation injury was high, namely 47.2% vs. 6.6% in patients without.

Based on our analysis, age and BSA(%) have moderate impact on mortality. LA50, taking into consideration age and BSA(%) together for the period 2010-2019, was improved up to 82.2%. The patients with inhalation injury, full thickness burns and with flame burns were associated with positive odds of a bad outcome.

Using AUC for the tested predictive scores, it was evident that all scores had good predictive values, with the BOBI score and ABSI score having the highest values of 0.826 and 0.825 respectively (p<0.001).

Table IV - ABSI score, BOBI score and RYAN score in the three periods of time from 1992 to 2019

			1992-2000 (n=1678)				2001-2009 (n=1840)				2010-2019 (n=1515)			
		MORTALITY	SURVIVED	DEAD	TOTAL	MORTALITY	SURVIVED	DEAD	TOTAL	MORTALITY	SURVIVED	DEAD	TOTAL	MORTALITY
		Predicted (%)				Observed (%)				Observed (%)				Observed (%)
ABSI score	**POINTS**													
	2-3	**1**	456	20	476	4.2	591	6	597	1.0	428	0	428	0.00
	4-5	**2**	618	94	712	13.2	656	37	693	5.3	513	1	514	0.19
	6-7	**10-20**	196	78	274	28.5	268	36	304	11.8	284	4	288	1.39
	8-9	**30-50**	53	59	112	52.7	109	37	146	25.3	125	19	144	13.19
	10-11	**60-80**	13	37	50	74.0	31	30	61	49.2	45	24	69	34.78
	>12	**90**	7	47	54	87.0	10	29	39	74.4	13	59	72	81.94
TOTAL			**1343**	**335**	**1678**		**1665**	**175**	**1840**		**1408**	**107**	**1515**	
BOBI score														
	0	**0-1**	664	35	699	5.0	793	9	802	1.1	550	0	550	0.00
	1	**1-5**	493	95	588	16.2	537	39	576	6.8	448	1	449	0.22
	2	**5**	75	32	107	29.9	151	20	171	11.7	161	2	163	1.23
	3	**10**	37	34	71	47.9	62	18	80	22.5	81	5	86	5.81
	4	**20**	43	34	77	44.2	52	18	70	25.7	64	11	75	14.67
	5	**30**	23	40	63	63.5	33	20	53	37.7	53	9	62	14.52
	6	**50**	5	33	38	86.8	30	25	55	45.5	38	14	52	26.92
	7	**75**	2	21	23	91.3	6	21	27	77.8	10	32	42	76.19
	8	**85**	1	10	11	90.9	1	4	5	80.0	3	20	23	86.96
	9	**95**	0	1	1	100.0	0	0	0	0.0	0	11	11	100.00
	10	**99**	0	0	0	0.0	0	1	1	100.0	0	2	2	100.00
TOTAL			**1343**	**335**	**1678**		**1665**	**175**	**1840**		**1408**	**107**	**1515**	
RYAN score														
	0	**0.3**	1163	132	1295	10.2	1357	50	1407	3.6	1042	3	1045	0.29
	1	**3**	152	91	243	37.4	240	54	294	18.4	257	20	277	7.22
	2	**33**	27	99	126	78.6	66	66	132	50.0	103	57	160	35.63
	3	**90**	1	13	14	92.9	2	5	7	71.4	6	27	33	81.82
TOTAL			**1343**	**335**	**1678**		**1665**	**175**	**1840**		**1408**	**107**	**1515**	

The strengths and limitations of the study

This study, being at the same time statistical and explanatory, gives the fundamental necessities to encourage reflection on outcome after severe burns. It will serve as a starting point for burn initiatives for treatment and implementation of prevention programs, among others. In this study we analyzed mortality only in relation to patient data on admission. Future research should encompass analyses of mortality related to other possible independent factors such as infection and related comorbidity.

We will end the article with a positive sentence, despite having mentioned the phrase "bad outcome" a lot of times. The following results come from the Global Burden of Disease (GBD), which estimates the annual number of deaths by cause. Deaths from fire and burns in Albania shows an outstanding decrease from 1.07 in 1990 to 0.52 per 100,000 people in 2017.[27] This information is in accordance with INSTAT as well as with our data. We hope to improve our results in the future.

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